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ABSTRACT

At Canada's University of New Brunswick (UNB), adult educators and computer experts jointly identified criteria for designing UNB's new Internet-based distance education delivery system called PSyCo (Presentation System for Courses). The 10 criteria that became the PSyCo blueprint were based on principles from three areas: architecture and design, cognitive environments and constructivism, and adult learning. Initially, the PSyCo system was designed to act metaphorically as the foundation, exterior, and interior walls of an unfurnished building rather than as another transmission vehicle unloading masses of information on learners. As a result, the software development team focused on function and virtually ignored aesthetics. The team also failed to consider the fact that students did not necessarily own the same high-end equipment. Eventually, input was sought from end users, and a visual design expert was brought into the project. Ten recommendations were developed for designers of Internet-based delivery systems in human dynamics terms through a process that models the constructivist view of learning. Software designers were advised to do the following: keep to real-world scenarios and problems; accept self-responsibility in declaring conflicting needs and staying the course; and acknowledge value-laden differences in skills, styles, and objectives. (Contains 25 references) (MN)

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IT'S BUILDING, BUT IS IT DESIGNING?: CONSTRUCTING INTERNET-BASED LEARNING ENVIRONMENTS.

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Constructivism, software design, adult learning, Internet, design criteria.

Introduction

Our title is modelled on a line from the US playwright Tennessee Williams, who after reading a script is reputed to have asked: "It's typing, but is it writing?". His distinction between technique and expertise and his detection of discrepancies between appearance and quality are skills we value in our use of any technology.

Distinctive thinking is a skill to focus on, we believe. We are awash in descriptions of techniques for Internet technology use without many examples of reflective and creative thinking about what might and might not work for learners and teachers. In addition, we see examples of the "old wine in new bottles" effect, meaning that educators who unthinkingly use new technologies for the same old purposes may end up wasting new opportunities for interactivity and effective learning. Being detective demands asking new and difficult questions and confessing design mistakes. So when we think distinctively about any given technology, we echo Tennessee Williams and ask "*It's building, but is it designing?*"

To help find some answers, we explore here how architects and other designers tend to think, and then link their approaches to our thinking about cognitive environments. We relate some general design principles to an Internet software design project at our university, and reflect on any significance of our experience. We ask you to figure out how design principles sometimes do not get applied. But first you deserve a context, a 'space' that details our beliefs.

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E J Burge

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

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Our beliefs

Our use of the words build, design and construct are not accidental. The more we teach, listen to learners, and reflect on how we ourselves learn, the more we believe in the use of constructivist approaches to education. The more we reflect on the fact that we are in the business of designing learning environments, the more we think we can learn from other construction-related disciplines such as architecture and industrial design. And the more we think about learning and constructing, the more we know we have to focus on their dynamics.

Our approach follows in part the aphorism of the Canadian communications philosopher, Harold Innis, who once wrote "Most forward-looking people have their heads turned sideways". We use his idea to argue that the 'sideways' knowledge of educators--what we have learned over the past 50 years--is not wasted knowledge, and that what other professions have learned may be very useful for expanding our intellectual landscape. We also believe that there is no single miracle technological cure for teaching problems (despite exhortations from the commercial sector or the keen early adopters in education).

We are not immune from 'thinking confusions' (Burge, 1996); i.e., confused thinking about which features in our educational and technological landscapes need attention first. For example, we can easily confuse mediation of distance with mediation of people, or confuse selling a software product with buying faculty client loyalty. We may even confuse institutional resources and learners' needs, as some of this paper shows.

So we try to clarify our thinking and walk our talk in several ways. First, the paper was made in a recursive and constructivist way (and we'll explain how in the last section). Second, we link our educational and computing knowledge with others' knowledge about adults as learners and constructivist learning to analyze our experience. Third, we dip into the fascinating literature of architecture and design to expand our thinking about the qualities of a constructed environment especially as they relate to how humans experience a 'place'. Fourth, we provide some experience-based guidelines to help you think creatively and constructively about your designs on the Internet.

Since using a logical, linear sequence is not a real-world process for most designers (Cennamo, Abell & Chung,1996; Murphy, 1996; Rowe, 1987), we begin walking on the third path to think about the functions and qualities of constructed environments.

Architecture and design

Urban planners, architects, and industrial and craft designers focus on designing features that promote the intended function of a landscape, building or artifact; they focus on how its elements are selected and configured for effective use (Barrie, 1996; Norman, 1988, 1993;

Rowe, 1987).

At the mega-level, Barrie refers to city planners' goals of "clarity and legibility" of the elements in the urban landscape if citizens are to identify and structure them accurately in order to live their lives efficiently (Barrie, 1996, p. 37). At the macro level, a building, whether built by animal or human architects, usually has one or more of five functions: "protection from external conditions, protection from predators, food collecting, communication, [and] ornamentation" (Pallasmaa, 1995, 54-55). How a building is used is affected by its features of composition (which elements are selected), articulation (how its space-forming and constructive elements fit together), and significance (meanings for its use)(Barrie, 1996, p. 148). At a micro level, designers of artifacts value the concepts of 'style', meaning aesthetics, simplicity, function, and timelessness (Enbom, 1995), and 'classic', meaning "user friendly, durable, versatile and suited to a variety of uses" (Stenros, 1995, p.3). Throughout the three levels we see operating the themes of security, integration, interaction, and movement.
It is easy to imagine how these themes may be experienced in various learning environments. But reaching those results is another matter. Which design principles are most likely to be helpful? To answer this question, and also because the Internet is fast becoming the 'everyday' for some of the world's population, we think about the "design of everyday things" and consider principles discussed by Norman (1988; 1993).

Essentially, two objectives should drive any design-- "provide a good conceptual model...and make things visible" (Norman, 1988, p.13). Four operational principles explain how to achieve modelling and recognition: visibility, affordance, natural mapping, and feedback. Taken as a group, these principles mean that whenever we use a tool or artifact, we will function best if we can understand how the object/tool works, which actions may actually be carried out, and the effect of our actions on that object/tool and on the environment.

How might these principles operate in a generic computer-conferenced environment? Look for (i) how easily and quickly a user can see how best to use hardware and software, e.g., how to move around between files (visibility principle); (ii) how readily the learner can take advantage of what the tool/object most easily allows, e.g., written asynchronous messaging (affordance); (iii) the extent of matching between the learner's original intentions and the actual actions demanded by the software, and the matching of learner's expectations and the system's provision of feedback about actual use, e.g., have an reply space placed after a sequence of messages and make it large enough that the learner can see her/his thoughts develop as sentences (natural mapping); and (iv) how fast the learner gets corrective or restraining actions when making operational errors, e.g. context-sensitive help or online coaching. We know when the principles are working because "the user can figure out what to do, and...can tell what is going on" (Norman, 1989, p.188). The user is rapidly oriented to all the features in the environment and has the tools for finding, changing and moving information. Sounds simple, doesn't it?

The modelling and recognition objectives are similar to those of the urban planner or architect who designs structures and spaces clear enough for easy interpretation of function and movement through them. Architects use the concept of 'cadence' to refer to the pace and quality of movement through a space or structure: e.g., "A pause in the cadence of the composition, either in music or architecture, produces a reaction of tension and anticipation" (Barrie, 1996, p. 48). When a natural form of movement through something is stopped or delayed, some kind of emotional reaction may be expected. Users of badly designed tools, for example, may easily feel high levels of frustration or (unjustified) incompetence.

Now, in the spirit of recursive thinking, let's leave for a while the design of constructed environments and move to functions and features of cognitive environments.

Cognitive environments

Our mental architecture, as we understand it, is a complex and self-initiated set of elements and dynamics. We follow a constructivist view of learning (e.g., Driscoll, 1994; Duffy, Thomas & Jonassen, 1993; Fosnot, 1996a; Steffe & Gale, 1995; Wilson, 1995). Any significant, i.e., personally meaningful construction of knowledge requires expertise and action internal to the learner. In this model, learners are their own knowledge architects, not photocopiers.

Constructivist views rely on several key ideas. First, meaningful learning is situated in real-world contexts and problems.

> We construct knowledge in order to deal with our experience...to deal with our experience means...to organize it in such a way that our actions bring about desired results (Bettencourt, 1993, p. 40).

People need to be able to explain how they see things work in the real world; " at creating mental models" (Norman, 1988, p. 198).

Second, a person's constructed knowledge frameworks are always in-process, laden with personal values and life experience, and mediated by the cultural and social norms in that person's world. Therefore no-one can 'photocopy' or learn exactly the knowledge as transmitted by an authority, e.g., a teacher (Fosnot, 1996b). The resulting learning may be "unique to the...self-regulating individual, but...not...idiosyncratic" (Fosnot, 1996b, p. 28).

Third, constructing one's own mental frameworks is hard work, to which many passive-dependent students can attest. The work calls for self-management and discipline, as well as organizing and making sense out of a mass of often 'messy' data selected from the external environment. Certain kinds of cadence, or rhythms of intellectual and emotional movement in learning have to be acknowledged. Learning is not a simple matter of steady accumulation of facts, like bricks to a wall; it is, rather, often an episodic process of intellectual engagement and withdrawal, of 'fast-forward' then 'slow-down', of certainty and confusion, for example

(Taylor, 1987).

Fourth, collaborative work amongst learners is productive, but it's not a licence for self-indulgent personal opinions or uncritical analysis of others' ideas. Opinions and life stories can act as useful data to help a learner see new or conflicting ideas, but then intellectual negotiations are needed to deepen the meaning-making. Negotiation of one's own meanings with those of peers, using skilful talking and listening strategies, works toward making meanings compatible, not replicated. Compatibility happens though "gradual accommodation [via social interaction] that achieves a relative fit"; rather than "giving, taking or sharing meanings as an existing commodity" (von Glaserfeld, 1996, p. 6). The cadence here now is a spiral and recursive kind of activity. We construct personal knowledge frameworks (assimilation) then find as we encounter real world problems that we may need to upgrade our knowledge in order to cope more effectively. All this often causes some disequilibrium or cognitive conflicts. Their resolution comes in the restructuring of the existing knowledge framework (accommodation). As Fosnot (1996b) points out, the key issue here is the dynamics--the interplay between existing knowledge and the socio-cultural elements that help to trigger the work of new learning.

When we add the element of the learner's adulthood to this complex mix, the dynamics heat up! In our experience, adult learners need environmental functions and features similar to those we listed above for well-designed constructed environments. Being recursive again, we summarize their functions as providing (i) a sense of significant place--a set of spaces and boundaries to enable easy movement without getting lost, (ii) helpful (but not necessarily always comforting) interpersonal dynamics to enable learners to "mess around" and negotiate meanings, and (iii) tools and resources to get the job done with minimum effort.

The features needed for such functions are, if well-designed, show a certain elegance. In the design world, 'elegance' is a demanding concept: the designer has to produce something that meets the four design canons listed by Norman, and, at the same time, shows an aesthetic sensibility. Such 'products' operate with deceptive simplicity because the designer has been able to strip away all and anything that is not essential for the key functions. No features get in the way or confuse the user; the form follows function.

Adults want comparable functions and features. Here are the five we think are foundational. (i) Adult learners look for some sense of a 'place' that helps them collect significant ideas, move freely around, express themselves, and feel some security that they are 'on the right path'. They may at times need a refuge, or protection, from the "whitewater rafting" sensations that come from information overload (Burge, 1994) or from the inevitable difficulties in re-structuring their knowledge frameworks (Taylor, 1987).

(ii) When they need help, they want fast and productive access to a more senior knowledge architect. They will make up their own mind about how much of that person's help is useful.

(iii) Adults in general use two basic intrinsic motivating drives--autonomy and affiliation (MacKeracher, 1996). So the dynamics in a cognitive environment have to promote independent and interdependent activity with cognitive as well as psycho-social support. An adult cannot be "motivated" by an educator; but an educator can try to remove as many dys-rhythmic and de-motivating elements as possible.

(iv) Adults as learners don't want to waste time learning to use tools that are not intuitive in their use, nor essential for the immediate tasks; nor be expected to act as educational researchers' 'guinea pigs'. Because they are managing multiple life roles, they look for economy of effort: "I want to use my mental powers for the important things, not fritter them away on the mechanics" (Norman, 1988, p. 193). Because they have developed individual and habitual ways of constructing knowledge, they may get somewhat disoriented when confronted by teaching styles that require new ways of thinking.

If you add to this mix the features of the Internet and other text-based communication strategies, we can propose more difficult questions: *"If we are to be designers rather than builders of technologically-mediated cognitive environments, what might the construction framework look like?" "What kind of blueprint could possibly be adequate?"* Let's scan the UNB design blueprint called PSyCo and you can answer the question that opened this paper--*"It's building, but is it designing?"*

The Blueprint

PSyCo (Presentation System for Courses) was to fill the void left by the decommission of the University of New Brunswick's MUSIC mainframe system. MUSIC had provided the university community with online conferencing and course management facilities. The interface to this course management software was 1970's architecture (menu-driven and text-based) but was familiar and well-liked. The prospect of losing this tool forced UNB Computing Services staff to evaluate replacement software, not write new software.

As things turned out, existing course management software could not easily and quickly be adapted to UNB administrative systems, so a software building process began. The PSyCo design team contained three programmer/analysts (Nicola and two other Computing Services staff) whose shared knowledge converged into technological expertise. After consultation with faculty, they established ten criteria which became the PSyCo blueprint.

The system must
1. be standards-based and not require users/ clients to install proprietary software;
2. use the University's existing administrative databases that hold personal and course-related information pivotal to all web and Internet-based activities at UNB;
3. free teachers from the burden of registering online course participants;

4. must work within the existing UNB web-based security framework;
5. provide a single window into all web-based course material;
6. provide a conferencing component, a venue for participants to engage in dialogue, speculation, argument;
7. have 2 "views" - the instructor's view and the student's view;
8. not have built-in tools for web page construction;
9. not impose any pre-designed 'look-and-feel' upon an instructor's web pages; and 10. support as low a common denominator of client software as practically possible.

In practice, these ten guidelines would promote the following conditions:
1. Faculty and students would be left entirely to their own devices in structuring the learning resources and the collaborative activities.
2. Faculty could place informational messages (welcome, course outline, course information, course bulletins), assignments and class notes either as clear text, or as pointers to pre-existing URL's. Faculty could optionally specify the dates for assignments and postings of class notes.
3. Faculty could define (and change) topics for discussion as the course progressed and assign students (all or in groups) to the course discussion topics. The flow and turns of conversation could be signposted somehow.
4. Faculty would see what the "student" sees, as well as perform course housekeeping functions.

In summary, PSyCo would act metaphorically as the foundation and exterior and interior walls of a building. The rooms would be unfurnished, open to carrying the tastes of their inhabitants. Because "less is more", there would be more design demands made of faculty to know how to use the building "constructively", rather than as another transmission delivery vehicle unloading masses of information on hapless learners.

A confession has to be made: The drive to meet functional and institutional goals and the tight time frame (July to September 1996) initially relegated aesthetics to a secondary position.

As small and homogeneous as the computing services development team appeared to be, they still had to engage in their own "social negotiations" (Cennamo et al, 1996, p. 42) to defend their choices to each other. While they could easily reach consensus on function, they diverged on matters of form.

The results

Had the technical folks been building or designing? The first version of PSyCo was a minimalist building with the design qualities and ambience of a bunker, built from grey walls with a stark typeface and colorless interior spaces. However, the functional goals of

the software team were achieved and the software, in their minds, was *working*.

> "When software engineers or programmers say that a piece of software *works*, they typically mean that it is robust, is reliable, and meets its functional specification... But this inward-looking perspective, with its focus on function and construction, is one-sided. To design software that really *works*, we need to move from a constructor's-eye view to a designer's-eye view, taking the system, the users, and the context all together as a starting point" (Winograd, p. xvi).

Aesthetic UNB faculty souls cried "Foul!" with righteous indignation. They felt that their values and work in designing a cognitive environment were being undermined. Typically they reacted affectively to the ambience of the space they had to inhabit. Apart from an easily functioning structure, they demanded form and aesthetic design -- as in the qualities of elegance and style listed above; even a welcoming spirit to create comfort and security.

The PSyCo design team was thrown off balance by these reactions and suggestions, and began to recognize that their effort was designer and product-centered rather than user and action-centered. Focussed on a product, they had missed the need to build up client loyalty. Nicola began to understand some andragogical principles. On finding out that learners did not have the same high-end equipment as they did, they regretted abandoning an original functional objective, i.e., to design for the lowest common denominator of client software. They realized that faculty and learner feedback would have given them useful data. Separation of form and function had lead to haphazard sacrifice of one for the other.

The software designers, like it or not, had to become part of a new dynamic interplay which now included other kinds of people--the actual users. These users even had the nerve to ask for delays in the release of PySyCo until the 'building' was partially fixed! So the software types had to discard the terms "Instructor" and "Student" (relics of their now-admitted ignorance of teaching adults). After prompting from Liz, they also invited a visual design expert on campus to draft several theme-based screens with appropriate use of color.

The attractiveness level rose somewhat. Screens began to look as in Figure 1. A notebook form 'shaped' the look and feel of the learner's opening screen.

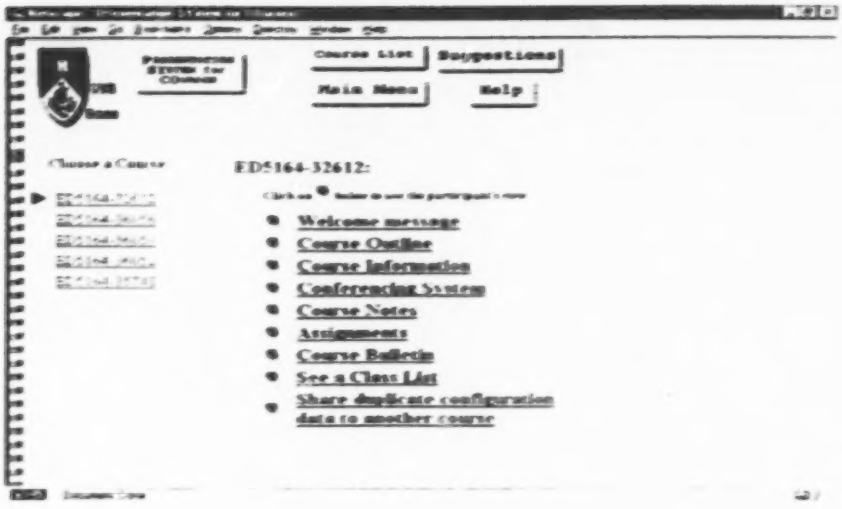

Figure 1. The "Notebook"

The buttons in the top third of the screen act as a visual metaphor; they suggest small post-it notes, and the background design is reminiscent of parchment. The screen follows Miller's "Seven plus of minus two" rule of thumb for limiting elements on a page to a effortless number (Miller, 1956).

The software designers continued to refine their design, adding various features, "improvements" as they saw them. New boxy grey buttons below the "post-its" were added to speed up the navigation between Main Menu items. While these additional icons might make PSyCo work better, they disrupt the interface's visual consistency. The course facilitator's opening screen now looked like this:

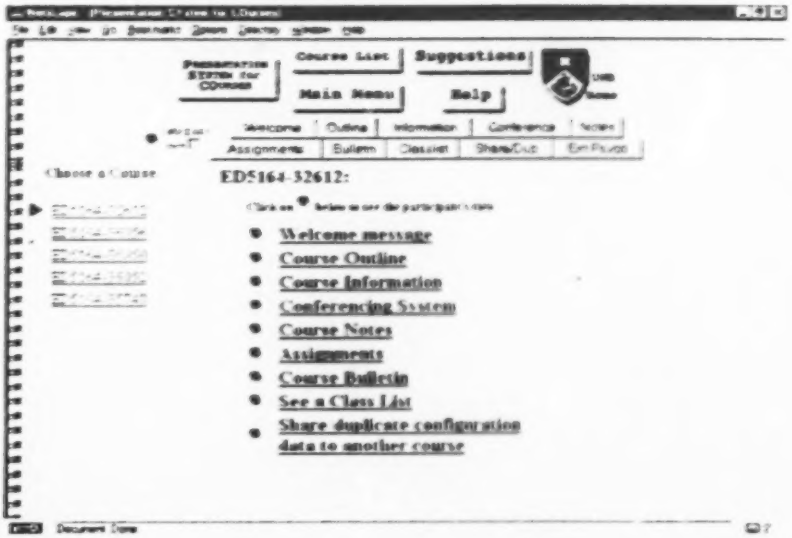

Figure 2. PSyCo's Final Look

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Time for better integration of form and function ran out; the software designers had followed the technical blueprint and now had to go to another project.

The learnings

After the experience of this all-too-short project, what did we all learn? How might we recognize designing, not building, processes in institutions? Norman makes our first contextual point: "Design should make use of the natural properties of people and of the world; it should exploit natural relationships and natural constraints" (Norman, 1998, p. 188). We make the second point, that is, the need for designers to acknowledge opposing elements and dynamics in a single context. We can see four such antinomies: real-world data but virtual world analysis; asynchronous messaging but synchronous thinking; copiable typing but uncopiable meaning-making; and technological ease but cognitive effort.

We see designing in human dynamics terms.

1. The development process incorporates end-users as well as computing experts. Faculty feel ownership in a product they will have to use long after the software designers have moved to other projects. Learners and teachers feel safe enough to give software developers 'real-world' reactions, no matter what the computer experts want to hear.

2. Designers look for 'sideways' knowledge from other professsions, e.g., librarians, ergonomists, and writers on how to write-to-think (Howard & Barton, 1986).

3. Administrators give enough time for the team to learn how to work together, and for the evolutionary aspects of human-software interaction designs.

4. Named design principles are openly discussed and used as evaluative criteria during learner and faculty testing.

5. Design focusses first on learning capacity development, not on computing capacity display.

7. User operational errors during pilot testing are regarded as qualitative data, not evidence of mental deficits.

8. Computer specialists assess the level of technological sophistication 'out there'. Designs for the computer specialists' high-end equipment may be useless in the field.

9. Look for unexpected results, the 'giving and the taking away' regarding elegance of software appearance and function (Postman, 1992).

10. In short, the designing process itself models the key ideas in a constructivist view of learning, i.e., keep to real-world scenarios and problems; accept the hard work of problem-solving; accept the self-responsibility in declaring conflicting needs and in 'staying the course'; collaborate; and acknowledge value-laden differences in skills, styles and objectives.

Role-modelling constructivism

We promised earlier to explain how the building of this paper role-models a constructivist approach. We number the criteria for role-modelling a constructivist approach in writing a paper.

We gave ourselves a real-world and personally significant (i) problem: How may we better understand the criteria for a well-designed Internet-based learning site?; while adding the "scholarly scaffolds" that inform our reflection (ii) and help our integration of new knowledge with old (iii).

We used a recursive and spiral (iv) route of thinking. Rather than writing out the paper from a pre-planned script, with clear divisions of work and a set time period, we went through several re-visits of what we thought we knew, finding out that we needed to assimilate new ideas (v), go try them out, then reflect and integrate (accomodate) (vi). This whole dynamic process-- oscillation between assimilation and accomodation -- helped us design a new thinking framework. More time (vii) than we originally expected was needed: Sometimes we had to just let ideas 'cook' subconsciously.

We used a reader-centred view (viii) to communicate our ideas. We tried to keep our expression direct and give you practical guidelines.

We collaborated. Rather than just dividing the writing workload, we negotiated our meaning-making (ix). That meant having to explain our own needs and knowledge, and listen to each other's knowledge and needs. We tried to respect the professional cultural distance between us. Nicola, for example, is the Expert (Cennamo, Abell & Chung, 1996) living in a computer analysts' culture; Liz is the Explorer/Skeptic living in an adult education culture. Into the collective mix of analytical, logical thinking with lots of software problem-solving patience (Nicola) and holistic, intuitive thinking with no patience for software user problems (Liz), we added a mutual appreciation for lateral ideas, humour, and cultural metaphors.

Finally, we relied on different and ways to represent our knowledge-building (x). Concept maps, musical analogies, diagrams, words,...whatever came to hand, eye, or mind.

And so we arrived at this point--the end of the paper, but not the end of knowledge-building. It's time now to expand the negotiation of meaning and ask for your reaction and 'constructive' comment.

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